Targeted Permeability Enhancement and ZVI Emplacement to Improve In Situ Bioremediation of a High-Concentration Source

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Background/Objectives. The Bountiful/Woods Cross Operable Unit 1 Site (referred herein as the Site) is located in southern Davis County, Utah, roughly 10 miles north of Salt Lake City. The several acre source area is impacted with elevated trichloroethene (TCE) concentrations including residual dense, non-aqueous phase liquid (DNAPL) from past industrial activities. The targeted treatment zone comprises heterogeneous deposits of dense, well-graded sand and gravel alternating with layers of sandy, silty clay. The complex lithology has led to incomplete contaminant destruction using in situ bioremediation (injection of emulsified oil and lactate via wells) due to the presence of residual DNAPL within the clays. The primary goal of the work was to evaluate the distribution of high concentration source material, and emplace sand and zero-valent iron (ZVI) within the low permeability units to allow for more effective treatment.

Approach/Activities. A TRIAD approach to investigation of the high-concentration (100 parts per million) TCE source was utilized to define the extent and distribution of contaminants, using high resolution membrane interface probe (MIP) data. A 3D model using Leapfrog® software was generated from the MIP data, with lithology interpreted from electrical conductivity and confirmed by boring logs. The 3D model and site lithologic logs allowed for development of a targeted approach to permeability enhancement (hydraulic fracturing), coupled with emplacement of ZVI, to address the high concentrations sorbed to the clays and silts. A series of permeability enhancement borings were drilled using direct push technology (DPT) in the vicinity of the source zone, with up to six individual enhancement intervals initiated within each boring. Tilt meter monitoring was used to evaluate extent of the enhancement network, and lithologic logs from new wells were used to confirm ZVI and sand distribution.

Results/Lessons Learned. The presentation conveys the importance of both a thorough subsurface investigation, especially in areas with residual DNAPL or extremely high contaminant concentrations, as well as targeted treatment of those intervals. Use of the 3D model allowed for detailed evaluation of areas requiring treatment, with easy identification of zones containing both high concentrations of contaminants as well as low permeability lithology. The hydraulic permeability enhancement allowed for targeted treatment of the most problematic intervals by emplacing ZVI and sand, which will provide both improved contaminant destruction, as well as ongoing contact with the contaminants due to new permeable pathways. A discussion of the approach to permeability enhancement will be provided, as the DPT-aided methodology was efficient and effective, with nearly 20,000 pounds each of ZVI and sand emplaced in a period of only five days. An assessment of the resulting permeability enhancement network, confirmation data, and comparison of contaminant degradation results from previous standard bioremediation techniques versus the ZVI-enhanced approach will be provided.